CO2 Pollution and Global Warming

When does carbon dioxide become a pollutant?

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CO_2 in the political spotlight

Carbon dioxide has taken center stage in the environmental arena in recent months. In August of 2003 the US Administration reversed the 1998 decision of the previous administration, which had classified carbon dioxide as a pollutant, and made it subject to the provisions of the Clean Air Act. As a result of the reversal of the 1998 decision, automobile manufacturers and power plants have been able to avoid making costly modifications that would have been required under the 1998 ruling. In 2006 environmental groups pushed for legislation that would reinstate carbon dioxide as a pollutant. In August of 2006 EPA General Counsel Robert Fabricant concluded that since the Clean Air Act does not specifically authorize regulation to address climate change, CO_2 is not a pollutant [(1)].

The reason given for not classifying CO_2 as a pollutant is based upon the fact that it is a natural component of the atmosphere and needed by plants in order to carry out photosynthesis. No one would argue the fact that carbon dioxide is a necessary component of the atmosphere any more than one would argue the fact that Vitamin D is necessary in the human diet. However, excess Vitamin D in the diet can be extremely toxic [(6)]. Living systems, be they an ecosystem or an organism, require that a delicate balance be maintained between certain elements and/or compounds in order for the system to function normally. When one substance is present in excess and as a result threatens the wellbeing of an ecosystem, it becomes toxic, and could be considered to be a pollutant, despite the fact that it is required in small quantities.

Finding the source of increased CO_2 in the atmosphere

The Carbon Cycle

Some scientists have suggested that when the earth was new (about 4.5 billion years ago), CO_2 may have made up as much as 80% of the earth's atmosphere. About 2 billion years ago, the concentration of CO_2 was likely 20 or 30%. Human life and even most life could not have survived in such an atmosphere. With the evolution of photosynthesizing plants, the concentration of CO_2 dropped and the percentage of oxygen in the atmosphere increased.

Remember that in photosynthesis:

CO_2 +H2O + energy from sun ==> O2 + sugar

Both plants and animals undergo respiration in which

Sugar + O2 ==> CO_2 +H20 + energy

In addition, when plants and animals die, the dead organisms decay and give off CO_2.

According to BBC Weather [(2)], the present amount of carbon dioxide taken out of the atmosphere every year by plants is almost perfectly balanced by amount of carbon dioxide put back into the atmosphere by respiration and decay. The carbon dioxide produced in this manner is part of a cycle in which new carbon does not enter the system, but rather it keeps changing in form. They might be contained in sugars, proteins, starches, cellulose and the list goes on and on. As living organisms undergo respiration (the metabolism of sugars to produce energy for basic metabolic needs), or as organisms die and decompose, the carbon compounds are broken down and add CO_2 to the atmosphere. The CO_2 is used by plants in the photosynthesis reaction, and the cycle keeps going.

Deforestation

When trees die and decompose, CO_2 is released. This is part of the normal carbon cycle. When trees are cut down and used for fuel, the CO_2 is also released. The rate at which CO_2 is released as a result of using trees for fuel is increased. However, when trees are used for building construction, furniture, etc, the carbon is not released rapidly into the environment. One would suspect then that harvesting trees for this purpose would result in less CO_2 release into the atmosphere for any given period. That might be correct, except that the tropical forests are being depleted, and with a reduction in vegetation, there is a reduction in photosynthesis. As a result, the carbon cycle is interrupted and the CO_2 is not being converted into sugars and oxygen. CO_2 accumulates. According to University of Maryland researchers [(3)], the UN reported that deforestation had decreased between 1980s and the 1990s, when, in fact, it had increased, and the CO_2 emissions from deforestation had increased. If CO_2 is increased due to deforestation, one would expect the oxygen level to decrease as a result of decreased photosynthesis.

Fossil Fuels

A third source of carbon dioxide comes from stored CO_2. The carbon found in fossil fuels was laid down over millions of years. Because the organisms did not decay completely, the carbon was never released into the atmosphere as CO_2. Instead, it was stored up in the earth. Once fossil fuel has been recovered, processed and burned, the CO_2, which would

normally have been released over tens of millions of years, is suddenly all released within a period of a few hundred years, thus increasing the amount of CO_2 in the environment.

Global Warming

Some scientists have suggested that ocean warming is resulting in increased CO_2 and not the other way around [5]. This is based on the idea that there is a lot of CO_2 trapped in the oceans, and as the temperature rises, the CO_2 is released, since the solubility of gases is inversely proportional to temperature. Oceans have long been considered to be a sink for atmospheric carbon. If it is releasing CO_2 as a result of warming temperatures, the CO_2 should be decreasing in the oceans.

Separating Carbon cycle CO_2, deforestation CO_2, oceanic CO_2 and fossil fuel CO_2

It becomes important to determine the source of the increase in CO_2 from 280 to 380 parts per million by volume between 1800 and 2005.

Isotopes of carbon may hold a key to determining the source of the increased carbon in the atmosphere [4,5,7]. The studies are based on the ratio of the three different carbon isotopes in atmospheric CO_2. Carbon has three possible isotopes: C-12, C-13 and C-14. C-12, which has 6 neutrons, is by far the most prevalent carbon isotope and is a stable isotope. Carbon 13 is also a stable isotope, but plants prefer Carbon 12 and therefore photosynthetic CO_2 (fossil fuel or wood fuels) is much lower in C-13 than CO_2 that comes from other sources (e.g.: animal respiration) Carbon-14 is radioactive. Studies of carbon isotopes in CO_2 has resulted in the following findings [5,7,8].

- There has been a decline in the 14C/12C ratio in CO_2 that parallels the increase in CO_2. In 1950 a scientist named Suess discovered that fossils do not contain 14C because they are much older than 10 half lives of 14C.
- There has been a parallel decline in 13C/12C ratio of atmospheric CO_2. This has been linked to the fact that fossil fuels, forests and soil carbon come from photosynthetic carbon which is low in 13C. If the increased CO_2 was due to warming of the oceans, there should not be a reduction in the ratios of C-13 and C-14 to C-12.

There are other clues that suggest the source of increased CO_2 is not related to the warming of the ocean and subsequent release of CO_2 from the ocean.

- There has been a decline in the oxygen concentration of the atmosphere. If ocean warming was responsible for the CO_2 increase, we should also observe an increase in atmospheric O2, because O2 is also released as the water is warmed.
- The ocean is a sink for atmospheric carbon, and the carbon content of the oceans has

increased by 118±19 PgC in the last 200 years. If the atmospheric CO_2 was the result of oceans releasing CO_2 to the atmosphere, the CO_2 in the ocean should not be rising as a result of ocean warming.

There is still some resistance to the theory that the increase in CO_2 results from the burning of fossil fuel, and that the increase in CO_2 is responsible for global warming. There is little pressure on the US power plants to reduce CO_2 emissions; so here it's still "Burning of fossil fuel is good for the environment" and "the world is flat." However, European power plants faced with reducing their CO_2 emissions significantly by 2008 and even more between 2008 and 2012 as required by the Kyoto Protocol, have embarked upon a unique way to reduce the CO_2 emitted into the atmosphere [(9)]. The technique known as carbon capture and storage (CCS) involves siphoning off and burying the CO_2 underground. While the CO_2 is not "gone," it is contained. For now they have to report it as "released CO_2," but The Department for Environment Food and Rural Affairs is working out plans to give industries credit for carbon capturing and storing in the second phase, from 2008-12, of the European carbon trading scheme. It will be interesting to see the effect of keeping the CO_2 from being emitted into the atmosphere. Of course, the next step would be to find a way to treat the stored CO_2 or find a use for it.

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